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# ECOLOGY OF SPRING SEEPS IN THE SACRAMENTO MOUNTAINS, LINCOLN NATIONAL FOREST, NEW MEXICO

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# FINAL REPORT

# ECOLOGY OF SPRING SEEPS IN THE SACRAMENTO MOUNTAINS, LINCOLN NATIONAL FOREST, NEW MEXICO

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ABSTRACT

Spring seep characteristics, watercress production within the spring seeps, and wildlife utilization of spring seeps were studied during the summer of 1982 until the spring of 1983 in the Cloudcroft district of the Lincoln National Forest, Otero County, New Mexico.

Spring seeps in open, riparian zone areas produced, on the average, the highest amount of watercress but were used the least by wild turkeys (Meleagris gallopavo merriami) as feeding areas when compared with spring seep sites in more closed non-riparian areas, even though these areas produced, on the average, lower amounts of watercress. Proximity to escape cover seemed to be important in selection of a spring seep as a feeding site.

Spring seeps were found to stay open during the winter providing areas where green forage, such as watercress, could be obtained.

Protein content of watercress was highest in spring and fall. Phosphorus content was highest in winter and spring while calcium content was highest in winter and fall. The protein, phosphorus, and calcium levels were lowest during the summer season.

Construction of some sort of low-level dam or series of dams to enhance the growth of watercress and provide for areas where seeds, mast, and animal materials could be trapped could be used to increase the value of spring seep areas to wild turkeys.

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# INTRODUCTION

Springs, seeps, and watercourses provide open, snow free areas during the winter months which are used by wildlife for feeding areas. One species of wildlife, the Merriam's wild turkey (Meleagris gallopavo merriami) could greatly benefit from these areas.

Researchers in the northeastern mountains of the United States have found spring runs and seeps to be an important component of the winter habitat of the eastern wild turkey (M. g. silvestris) (Glover 1948, Latham 1959, Bailey and Rinell 1968, Healy 1977).

In West Virginia, Glover (1948) found that during periods of heavy snow cover, turkey feeding areas were along streams and around permanent springs which provided green feed such as grasses and ferns. Glover also stated that permanent spring runs were important in determining the winter carrying capacity of a range.

Seeps contain a variety of plants and animals that might be available to turkeys as food items (Walls 1964). Also, the water flow from the seeps melts the snow and provides turkeys with access to the ground. The importance of seeps increases as snow depth increases (Healy 1977).

Healy (1977) described the difference between springs and seeps and also the characteristics of seeps used by wild turkeys. Springs discharge water from a fixed point and the flow usually forms a small stream; seeps occur where ground water percolates to the surface and forms a saturated area. Healy found that seeps with the greatest potential value to wild turkeys had a permanent flow, diffuse outlet, and a muck substrate. For the study in the Sacramento Mountains we will use the term "spring seeps" as many of these areas have characteristics of both springs and seeps, as described by Healy.

As mentioned above, springs and seeps provide areas for feeding during the winter months, and may provide green forage. This could be especially important in late winter and early spring in providing high protein green forage for turkeys as they approach the breeding season. Gardner and Arner (1968) stated that egg production of the wild turkey is significantly affected by diet, especially the level of consumption of protein. Successful laying by hens could be curtailed by deficiencies in such essential nutrients as protein, calcium, or phosphorus (Norris and Scott 1967). According to the National Research Council (1971) a diet containing 14% protein, 2.25% calcium, and 0.75% phosphorus is considered necessary for breeding domestic turkeys.

Not only do seeps provide areas where green forage is made available but also provide other food items. Healy (1977) found most seep areas, in the Monogahela National Forest of West Virginia, to be bowl-shaped and acted as seed traps as well as providing more lush herbaceous growth than the surrounding forest. Also in West Virginia, Glover (1948) observed areas where turkeys had scratched out areas along spring runs searching for beechnuts (Fagus grandifolia).

Because of the lack of information concerning the importance of spring seeps to the wild turkey in the Sacramento Mountains of New Mexico, this study was undertaken to assess the importance of these areas to wild turkeys and develop recommendations for enhancing the quality of these areas as food producing sites. Field work was conducted from summer 1982 to spring 1983, in the Cloudcroft District of the Lincoln National Forest. Funding was provided by the United States Forest Service.

## STUDY AREA

The study area was located within the Cloudcroft District of the Lincoln National Forest, Otero County New Mexico (Figure 1). Criteria used in selection of spring seeps were:

1. Accessability to spring seeps during all 4 seasons of the year.
2. Occurrence of watercress within the spring seeps.
3. Enough differences between spring seep areas to be representative of the different environmental conditions in which watercress will occur.

Elevations range from 2300 m to 2960 m with mountainous topography, gently sloping to moderately steep on ridge tops and valley areas to very steep on side slopes. Soils are predominantly of the Caballo-Peso-Rockland association and Peso-Mescalero association (Maker et al. 1972). They are typically dark colored, with a moderate to high content of organic matter. The soils originate from materials weathered residually from underlying limestone bedrock or in colluvial and alluvial sediments from such rocks.

The area is completely within the mixed conifer associations described by Moir and Ludwig (1979), and include 6 forested climax types, a non-forested dry meadow type and many seral associations. Major overstory trees are white fir (see Appendix A for scientific names), Douglas fir, Engelmann spruce and blue spruce. Major seral trees include southwestern white pine, ponderosa pine, aspen and Gambel oak.

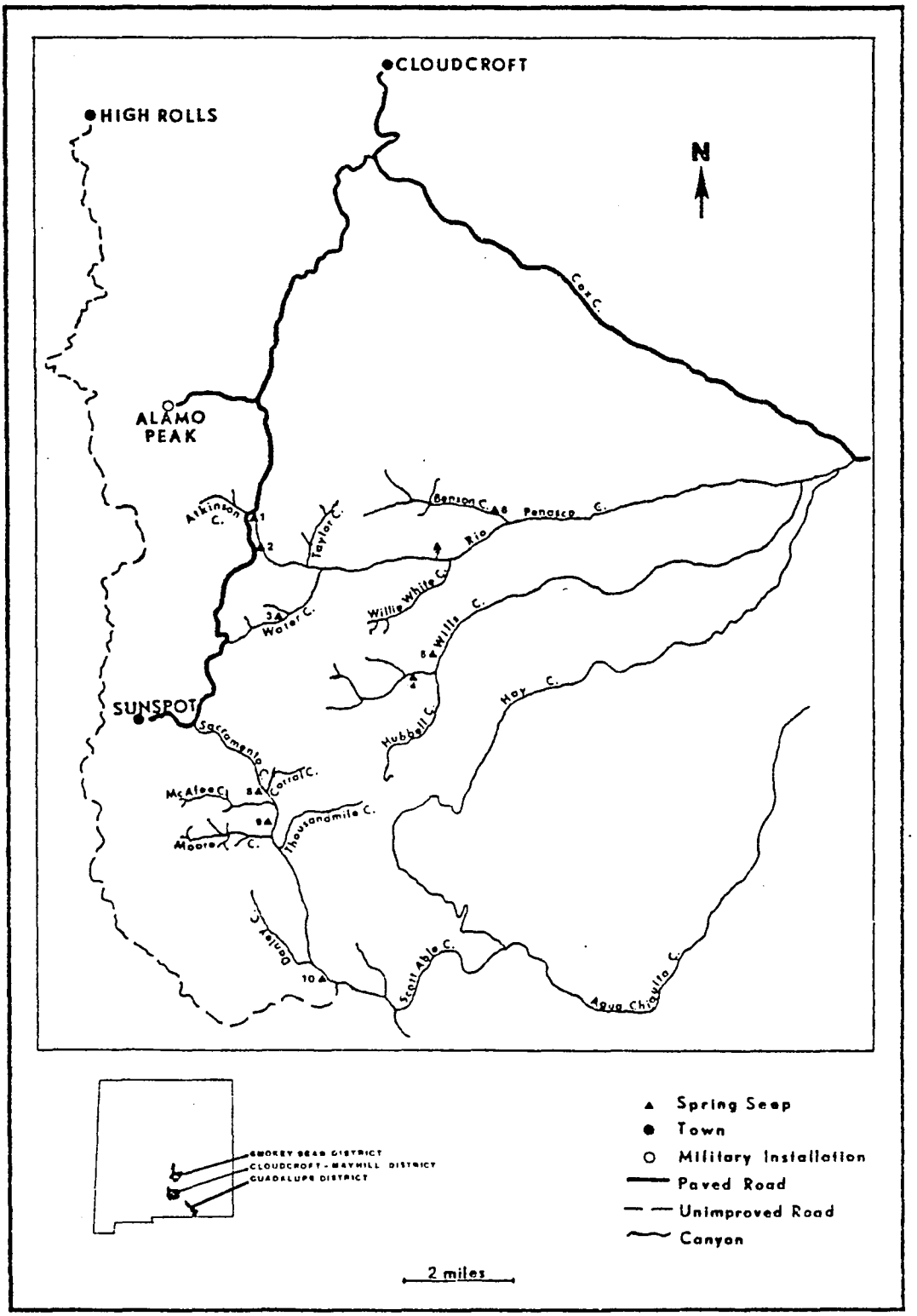


Figure 1. Location of spring seep sites, Cloudcroft District, Lincoln National Forest.

Logging and livestock grazing have been in effect since the 1880's and fire has been a predominant factor in maintaining large areas of seral vegetation (U.S. For. Serv. 1978).

The climate is montane continental, characterized by cold winters and mild summers. At Sunspot Observatory, located in the study area, the mean annual precipitation is 59.6 cm (Demastus 1976). Two-thirds of the annual precipitation is contributed by summer thunderstorms. The balance occurs in the form of snow, with an annual mean accumulation of 182.4 cm. The freeze-free period averages 143 days, with temperature minima and maxima means of 10°C and 23°C in the summer and -6°C and 3°C in the winter. Record extremes are 34°C and -31°C.

Locations of spring seeps are shown in Figure 1 and Table 1.

Table 1. Location of spring seeps, Cloudcroft District, Lincoln National Forest.

| Seep # | General Location | Specific Location |
|---|---|---|
| 1 | Upper Rio Penasco River (just below turnoff to Rio Penasco Road) | NE¼, Sec. 11, R12E, T17S |
| 2 | Upper Rio Penasco River (200 yards downstream from seep #1) | SE¼, Sec. 11, R12E, T17S |
| 3 | Water Canyon | NW¼, Sec. 24, R12E, T17S |
| 4 | Upper Wills Canyon (above abandoned barn) | NE¼, Sec. 29, R13E, T17S |
| 5 | Upper Wills Canyon (near turnoff to Hubbell Canyon) | SE¼, Sec. 20, R13E, T17S |
| 6 | Benson Canyon | NW¼, Sec. 10, R13E, T17S |
| 7 | Bluff Springs | SE¼, Sec. 8, R13E, T17S |
| 8 | Upper Sacramento River | SE¼, Sec. 2, R12E, T18S |
| 9 | Sacramento River, Thousandmile Canyon | NE¼, Sec. 11, R12E, T18S |
| 10 | Lower Sacramento River, Hornbuckle Hill | SE¼, Sec. 24, R12E, T18S |

## METHODS

### Spring Seep Characteristics

Ten spring seeps were inventoried during the spring, summer, fall, and winter seasons, beginning during the summer of 1982 and ending in the spring of 1983. Length and width of the spring seep area, slope of the ground at the spring seep site, soil depth, soil type, water flow rate, and water temperature during the winter season were assessed for each site.

Length and width of the spring seep site were determined using a 30.5 m (100 ft.) tape or by pacing. Slope or gradient at the site was measured with a "Suunto" clinometer. Soil depth was measured with a 1 meter rule. Flow rates were measured with a Pygmy Current Meter[1] and winter water temperatures were measured with a YSI Model 33 S-C-T Meter[2].

### Watercress Analysis

Peak biomass of watercress was determined by clipping and weighing. Watercress was collected during the period in which it was flowering (i.e. summer) to determine the productivity of the seep site. Two ½ meter square plots were laid out within each seep area. Watercress was clipped above ground (i.e. no root material was used) and was then bagged and frozen. Samples were then returned to the lab, thawed,

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[1]Scientific Instruments Corp., 25 Broadway, Pleasantville, NY, 10570.

[2]Yellow Spring Instrument Co., Inc., Box 279, Yellow Springs, OH, 45387.

cleaned of all soil and detritus, air dried, then dried for 1 week in an air flow drying cabinet at 49°C (120°F) for 4 days. The samples were then oven dried at 65°C (159°F) for 48 hours. The samples were then weighed, to the nearest 0.1 gram, on a triple-beam balance.

All samples collected during the study were subjected to chemical analysis to determine crude protein, phosphorus, and calcium levels during the 4 seasons of the year. Samples for chemical analysis were collected using the same procedure as for the biomass collection except that 1 square meter of material was not needed for this analysis. Drying procedure was the same for all samples whether used for biomass determination or chemical analysis.

Samples for chemical analysis were ground through a 2 mm mesh screen before being subjected to analysis. Macro-Kjeldahl analysis for protein, analysis of calcium content, and analysis of phosphorus levels were conducted according to procedures outlined by the AOAC (1975).

## Animal Utilization

Utilization of seep areas by wildlife and livestock were determined by direct observation and/or presence of tracks and droppings.

# RESULTS

## Spring Seep Characteristics

The physical characteristics of the spring seeps were assessed to obtain base data on the conditions for growth of watercress (Appendix B). Areas where watercress grew within the spring seeps varied widely in respect to width ($\bar{x}$ = 9.5 ± 13.9 m, range = 1.8 m - 45.7 m), length ($\bar{x}$ = 259.3 ± 265.5 m, range = 6.1 m - 804.7 m), and soil depth ($\bar{x}$ = 30.5 ± 24.9 cm, range = 2.5 cm - 86.4 cm). The greatest similarities occurred between percent slope (gradient ($\bar{x}$ = 4.3 ± 3.9%, range = 1% - 12%), soil type (dark silt with some sand), and flow rate (<0.03 ft/sec). Average winter water temperature was 6.8 ± 4.1 °C. A summary of spring seep characteristics is shown in Table 2.

Spring seep sites varied from broad, flat, open areas within riparian zones (Figures 2, 3, 4) to areas along small springs in close proximity to the forest canopy (Figures 5, 6, 7). On the average, the greatest watercress production, based on peak standing crop, occurred in the more open, riparian areas, seeps numbers 1, 2, 4, 8, 9, 10 (Figure 8), compared to the "non-riparian" type seeps numbers 3, 5, 6, 7. Watercress was found to grow best in areas of low water flow, flat topography, and a good soil or "muck" substrate.

## Watercress Analysis

Crude protein content of watercress was highest in the fall season (21.65%), followed by spring (21.56%), winter (21.05%), and summer (19.86%). Phosphorus levels were highest in winter (0.267%) followed by spring (0.252%), fall (0.248%), and summer (0.215%). Calcium levels

Figure 2. Spring seep in riparian area. Watercress occurs in low flow area beneath elderberry bush. Spring seep #2.

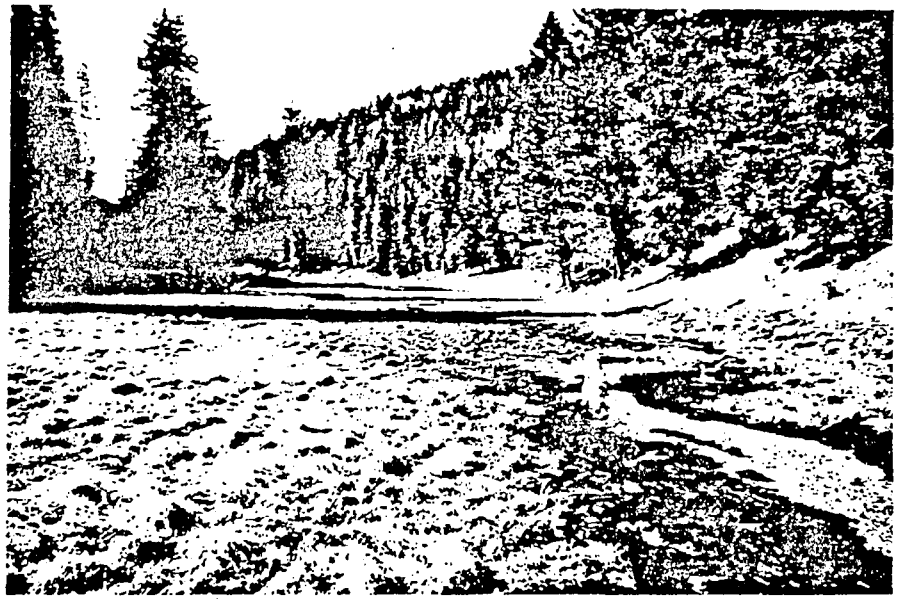

Figure 3. Spring seep in riparian area with good watercress production but in a large open area. Spring seep #9.

Figure 4. Spring seep in riparian area along a road. Watercress at this site was completely removed by cattle during the fall season with little regrowth until spring. Spring seep #8.

Figure 5. Spring seep in non-riparian area with good growth of watercress and close proximity to escape cover. Spring seep #7.

Figure 6. Spring seep in non-riparian area. Three hen turkeys were observed feeding at this site during the winter season. Spring seep #3.

Figure 7. Spring seep in non-riparian area. Low-level dams create a low flow situation for watercress growth. Spring seep #5.

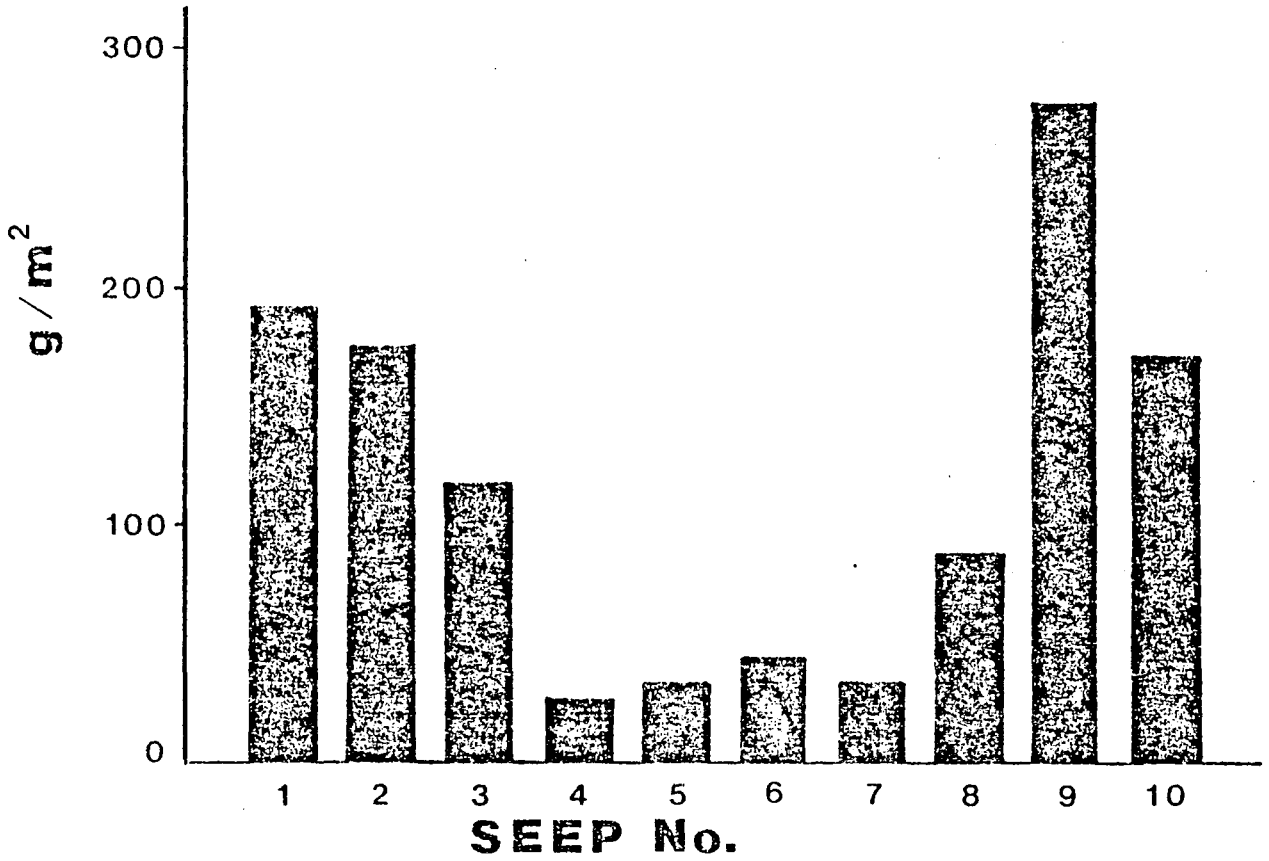


Figure 8. Peak biomass of watercress in spring seeps.

Table 2. Summary of spring seep characteristics, Cloudcroft District, Lincoln National Forest.

| | | |
|---|---|---|
| Length | $\bar{x}$ = 850.8 ± 870.9 ft. (259.3 ± 265.5 m) | range = 20 - 2640 ft. (6.1 - 804.7 m) |
| Width | $\bar{x}$ = 31.2 ± 45.7 ft. (9.5 ± 13.9 m) | range = 6 - 150 ft. (1.8 - 45.7 m) |
| % Slope | $\bar{x}$ = 4.3% ± 3.9% | range = 1% - 12% |
| Soil Depth | $\bar{x}$ = 12 ± 9.8 in. (30.5 ± 24.9 cm) | range = 1 - 34" (2.5 - 86.4 cm) |
| Flow Rate | <0.03 ft/sec. | |
| Soil Type | Silty, some fine sand, with pea sized gravel in 2. instances. | |
| Temperature | $\bar{x}$ = 6.8 ± 4.1°C | range = 2 - 15°C |

were highest in winter (6.65%), followed by fall (6.52%), spring (6.02%) and summer (4.75%). Percent dry matter, percent ash, percent crude protein, percent phosphorus, and percent calcium levels are shown in Table 3.

## Animal Utilization

Four out of the 10 spring seeps had visible utilization by turkeys (i.e. droppings and direct sightings). These were spring seeps 3, 5, 6, and 7 (Figure 1, Table 1). These were the 4 non-riparian areas which were in closer proximity to the forest edge than were the riparian areas.

Turkey use of spring seeps was most prevalent during the winter and spring seasons. Both hen and gobbler droppings were observed at the sites during these periods. In one instance, 3 hens were observed feeding at a spring seep (spring seep #3). No evidence of spring seep use was observed during the summer or fall seasons. Spring seeps 1 and 8 were used heavily during the fall season by cattle and were heavily grazed to the point that most of the watercress in these areas was removed or trampled.

Table 3. Chemical analysis of watercress found in spring seeps, Cloudcroft District, Lincoln National Forest.

| Season | Crude Protein (%) | Calcium (%) | Phosphorus (%) | Dry Matter (%) | Ash (%) |
|---|---|---|---|---|---|
| Winter | 21.0539* | 6.65 | 0.267 | 94.3229 | 33.7323 |
| Spring | 21.5604 | 6.02 | 0.252 | 95.2821 | 33.0715 |
| Summer | 19.8571 | 4.75 | 0.215 | 94.7322 | 26.9885 |
| Fall | 21.6469 | 6.52 | 0.248 | 94.4760 | 29.5294 |

*All values in this table are averages on a seasonal basis.

# DISCUSSION

## Spring Seep Characteristics

Supplemental winter feeding of wild turkeys, its advantages and disadvantages, has been researched and discussed by several authors (Latham 1959, Wunz and Hayden 1975, Pattee and Beasom 1979). Latham (1959) stated that the arguments for winter feeding include: (1) deep snowfall limits the turkeys' ability to secure natural foods, (2) artificial feeding is needed during years of generalized mast failures, (3) unless the birds emerge from the winter in good physical condition, reproduction will be curtailed. Points one and two are true in the sense that deep snowfalls and mast crop failures make it more difficult for turkeys to obtain food but they are able to utilize food items above the snow, along spring runs and seeps, and also are able to switch to other food items so that mast crop failures are not as detrimental as they might seem.

Pattee and Beasom (1979) found that the supplemental feeding of wild turkeys in Texas, fed with a commercial pelleted ration of 17.5% protein, 2.25% calcium, and 0.75% phosphorus, may increase the annual surplus of turkeys but no evidence was found to indicate that turkey populations increased due to supplemental feeding. Also, poult survival and clutch size were apparently unaffected by supplemental feeding.

In the Sacramento Mountains, management practices that would enhance natural feeding areas such as spring seeps would be more beneficial to the turkeys than artificial feeding. Lindzey (1964) found that supplemental winter feeding of wild turkeys in Pennsylvania was not only expensive, but also the winter food habits of the birds were

changed and their range was affected by the presence of feeders. These problems could be alleviated by increasing food production in areas that turkeys already utilize for foraging. In the Sacramento Mountains, management of spring seep areas could be a main method of increasing the winter food supply for wild turkeys.

Spring seeps in the Sacramento Mountains usually stayed open all winter long, except in situations where deep snows drifted over the seeps, and provided turkeys with available food items, such as watercress, throughout the winter. Spring seeps with the greatest watercress production occurred in the more open, riparian areas. Lindzey (1964) stated that spring seep areas in Pennsylvania provided, on an average, 21.2 $g/m^2$ of food for wild turkeys. In the Sacramento Mountains, watercress, an important winter food for turkeys, averaged 115.1 $g/m^2$ per spring seep. Even if only one quarter of this biomass lasted into the winter season, these areas could still provide, on an average, 28.8 $g/m^2$ of potential forage in watercress alone. This figure does not include the other herbaceous material, seeds, or animal foods that also may be available to turkeys as food items.

## Watercress Analysis

Turkeys in both the wild and in captivity have been known to not eat for long periods of time. It has been reported that wild turkeys have stayed on the roost without food or water for as long as 4 days during periods of heavy winter snowstorms (Glover 1948). A captive turkey was kept in an unheated room where temperatures ranged between 34° and 50°F and survived for 24 days without either food or water (Gerstell 1942). It also has been reported that fertility,

hatchability, and egg and poult weights were not affected by a pre-breeding season weight loss of 20-30 percent of body weight of hens (Hayden and Nelson 1963). Porter et al. (1983) found that winter condition of hens did not significantly affect the initiation of egg-laying but may affect clutch size and renesting.

Protein, calcium, and phosphorus requirements for domestic breeding turkeys have been reported as approximately 14% protein, 2-2.25% calcium, and 0.7-0.75% phosphorus (NRC 1971, 1977).

Treichler et al. (1946) stated that calcium and phosphorus are essential for proper growth and reproduction, but are not essential for survival during periods of adverse weather when the primary requirement is energy. Some of this energy is provided by protein in the foods eaten. Beckerton and Middleton (1982) found that captive ruffed grouse fed increasing levels of dietary proteins increased duration of laying, rate of laying, clutch size, weight of the first egg, mean egg weight, hatching success, chick weight at hatching, and chick survival.

Calcium and phosphorus are essential nutrients in the diet of turkeys and deficiencies can affect reproduction. Atkinson et al. (1964) found that optimum calcium and phosphorus levels for domestic turkey breeders was 2.54% calcium and 0.61% phosphorus. According to Jensen et al. (1963), there was depressed egg production in domestic turkeys at calcium levels of 1.0% but optimal egg production occurred at the 1.75% level. High levels of calcium (2.5-3.25%) in the diet depressed hatchability and interfered with the utilization of manganese and zinc. Greeley (1962) found that hen pheasants on a low calcium diet (1.09%

and less) produced few eggs and a reduction in the thickness of the eggshells was observed.

Watercress sampled in the spring seeps in the Sacramento Mountains was comparatively high in protein on a year round basis. Watercress contained a higher amount of protein during the spring season (≈21.6%) than any single species food item found by Pattee and Beasom (1981) being eaten by Rio Grande turkeys in Texas, with the exception of insects. Watercress was also higher in protein than any of the 8 fall and winter foods of eastern wild turkeys reported by Billingsley and Arner (1970). It seems that by consuming watercress, wild hen turkeys in the Sacramento Mountains could meet their protein and calcium requirements during the winter and spring seasons, which would prepare them for the breeding season. The phosphorus level of the watercress, however, was low compared to the 0.7-0.75% recommended for domestic breeder turkeys.

Schemnitz et al. (1983) found that watercress constituted 39%, 5%, 19%, and 31% of the diet of wild turkeys in the Sacramento Mountains during the spring, summer, fall, and winter, respectively. Pattee and Beasom (1981) calculated the relative contribution of food items eaten by wild turkeys to the total crude protein, calcium, and phosphorus content of the diet by multiplying a food item's percent nutrient content (determined from hand-picked samples) by its relative composition (by dry weight) in the turkey crops. The fecal analysis used by Schemnitz et al. (1983) for the Sacramento Mountains turkeys does not lend itself to this kind of examination. However, a high protein food item such as watercress, which during some seasons constitutes one third or more of the turkey's diet, should have a positive influence

on the nutritional quality of the diet of the turkeys. In effect, watercress has the potential for providing wild turkeys with ample quantities of protein and calcium to meet their nutritional needs.

## Animal Utilization

Observed use of spring seeps by wild turkeys was exclusively in areas where the spring seep was in close proximity to escape cover (i.e. <30 m from the forest canopy). Larger, more open areas were not observed to be used.

Grazing of spring seep areas by livestock (i.e. cattle) was found to be detrimental to watercress production in two instances. In these instances, cattle completely consumed all of the above ground parts of the watercress. This defoliation of the watercress is especially critical in the fall since it is more difficult for the watercress to grow during the fall and winter seasons.

Degradation of spring seeps by human activity may also be a problem in the Sacramento Mountains. Spring seep areas near unimproved roads and trails can be severely damaged by vehicles being driven through them (Figure 9), especially during high use periods such as hunting seasons and during cross country motorcycle races. Camping activity in close proximity to spring seep areas also could reduce the value of the spring seep area to turkeys and other wildlife.

## Spring Seep Management

Spring seeps with the greatest watercress production tended to be in the more open, riparian areas. However, the spring seeps with the greatest turkey utilization were those spring seeps which were closer

Figure 9. Vehicles driven through this spring seep during the spring turkey hunt have reduced its value for wildlife. Spring seep #6.

to the forest edge and were thus in close proximity to escape cover. Therefore, some kind of manipulation to increase production of watercress in the non-riparian type areas would increase their value to wild turkeys. This would probably be more desirable than modifying sites in the riparian zones to increase escape cover, in terms of cost and agreement with other uses of the forest (i.e. grazing and timber management).

Healy (1977) in a study in West Virginia, found that spring seeps with the greatest potential value for turkeys were characterized by; (1) a diffuse outlet, (2) a muck substrate, (3) a southern exposure, and (4) position on the lower portion of the slope. He also stated that the value of a seep usually increases as its size increases; value is also enhanced if the seep occurs along a small stream or near other seeps.

In the Sacramento Mountains, spring seep areas with the greatest watercress production exhibited most of the characteristics described by Healy. These areas also had the lowest amount of use by turkeys. This would suggest that in the Sacramento Mountains, proximity to escape cover is also important in the value of a spring seep to wild turkeys. To increase the productivity of the non-riparian sites, in terms of watercress production, some sort of system for decreasing the water flow, creating diffuse outlets, and increasing the depth of the muck substrate would be helpful to create an environment suitable for increased watercress production.

One such system would be a low-level dam or series of dams. These could be constructed easily, with little initial cost, and little maintenance, while using materials found nearby within the forest. These dams need not be permanent. After watercress is transplanted into

these newly created areas and has had time to become established, silt and other debris will become trapped by the growing vegetation thus creating a self perpetuating system. Organic debris dams are better for this purpose than dams constructed with artificial materials. Bilby and Likens (1980) studied the importance of organic debris dams in stream ecosystems and found that these dams are extremely important components of small stream ecosystems. They retain organic matter within the system, thereby allowing it to be processed into fine fractions. They explained the formation of naturally occurring dams as forming when a piece of large woody material, such as a tree branch, falls into the stream and lodges against rocks and boulders protruding from the streambed. Smaller pieces of woody debris are then caught against the larger piece and provide a framework on which leaves can accumulate. Ultimately, the structure becomes almost watertight, forming a pool on its upstream side where sand, silt, and other fine sediments can settle.

As can be seen, construction of dams can be quite simple, inexpensive, and provide areas suitable for high watercress production. These areas also can provide traps for seeds, mast, and animal material which also can be used as food items by wild turkeys.

While searching for suitable spring seeps with watercress several seeps without watercress and/or aquatic plants were observed. These spring seeps seemed to have ideal growing conditions and would be ideal areas for experimental transplanting of watercress.

## MANAGEMENT RECOMMENDATIONS

1. Create low flow situations (<0.03 ft/sec.) in spring runs and streams using some type of log structure which allows flow of water over or around structure.

2. Fence areas around seeps and springs to prevent cattle grazing. Water can be piped to troughs for livestock use.

3. Close road accesses in areas where the operation of motor vehicles could disrupt wildlife usage of spring seep sites.

4. Attempt to divert human activities, such as camping, away from spring seep areas.

5. Guidelines for watercress transplanting:

   a. Make sure the transplants site has a slow flow rate (less than 0.03 ft/sec) and a sufficient "muck" substrate (minimum of 12 inches) for growth of watercress.

   b. Transplant watercress during the growing season (i.e. spring and summer).

   c. Use whole plants for transplanting. Using a "mat" of vegetation for transplanting would be best.

   d. Keep watercress wet during transport to the planting site.

   e. Plant watercress in areas where the flow of water is the lowest, <0.03 ft/sec. or along banks where the water flow is low.

   f. Plant watercress in areas where the water is more than 8 inches deep.

6. Try to manage spring seep areas that are close to escape cover for watercress production.

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## LIST OF SCIENTIFIC NAMES

| Common Name | Scientific Name |
|---|---|
| **Plants** | |
| Aspen | *Populus tremuloides* |
| Blue spruce | *Picea pungens* |
| Douglas fir | *Pseudotsuga menziesii* |
| Elderberry | *Sambucus caerula* |
| Engelmann spruce | *Picea engelmannii* |
| Gambel oak | *Quercus gambelii* |
| Ponderosa pine | *Pinus ponderosa* |
| Southwestern white pine | *Pinus strobiformis* |
| Watercress | *Nasturtium* sp. |
| White fir | *Abies concolor* |
| **Animals** | |
| Merriams wild turkey | *Meleagris gallopavo merriami* |

Table 4. Measurements of 10 spring seep sites[1].

| Seep # | Width (yd.) | Length (yd.) | % Slope | Soil Depth (in.) | Soil Type | Winter Water Temp. (°C) |
|---|---|---|---|---|---|---|
| 1 | 4.3 (3.9)* | 440 (402.3)* | 1.0 | 19 (48.3)** | silt | 2.0 |
| 2 | 5.3 (4.8) | 9 (8.2) | 2.5 | 20 (50.8) | sandy-silt | 2.0 |
| 3 | 2.0 (1.8) | 100 (91.4) | 7.5 | 34 (86.4) | sandy-silt | 7.0 |
| 4 | 1.5 (1.4) | 6.7 (6.1) | 5.0 | 6.0 (15.2) | sandy to pea sized gravel | 7.0 |
| 5 | 3.7 (3.4) | 50 (45.7) | 12.0 | 6.0 (15.2) | sandy to pea sized gravel | 10.0 |
| 6 | 5.3 (4.8) | 30 (27.4) | 5.0 | 8.0 (20.3) | silt | 15.0 |
| 7 | 5.3 (4.8) | 440 (402.3) | 6.5 | 1.0 (2.5) | sandy-silt | 9.0 |
| 8 | 3.3 (3.0) | 880 (804.7) | 1.0 | 8.0 (20.3) | silt | -- |
| 9 | 23 (21.0) | 440 (402.3) | 1.0 | 12.0 (30.5) | silt | 5.0 |
| 10 | 50 (45.7) | 440 (402.3) | 1.0 | 6.0 (15.2) | silt | 4.5 |

*meters **centimeters.

[1]All flow rates were less than 0.03 ft/second.